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A SURVEY OF THE POLE RESOURCE IN THE NORTHERN BLACK HILLS

by

Gilbert H. Fechner

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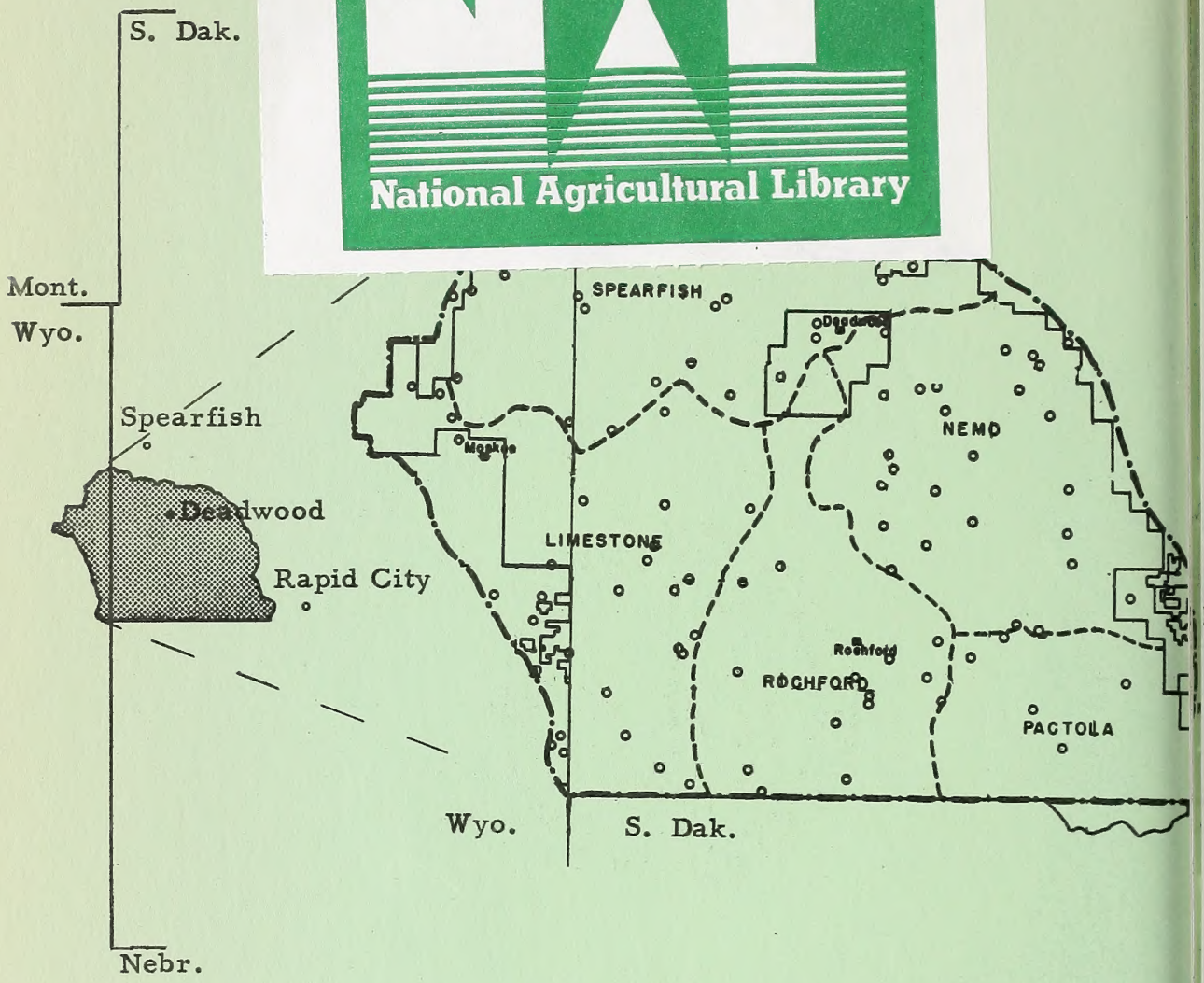

Legend:

— - — - — - — Boundary of survey

o Location of sample plots

— — — — — — — District boundaries

A SURVEY OF THE POLE RESOURCE IN THE NORTHERN BLACK HILLS

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Gilbert H. Fechner[1/]

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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Fort Collins, Colorado

The station maintains headquarters at Fort Collins
in cooperation with Colorado State University

1/ Assistant professor of forest management, College of Forestry and Range Management, Colorado State University. Mr. Fechner supervised the field and office work under the direction of Lincoln A. Mueller, Chief, Division of Forest Utilization Research, Rocky Mountain Forest and Range Experiment Station.

INTRODUCTION

In 1952, nearly 49 billion board-feet of live sawtimber were cut from the forests of the United States. About 1 percent of this total was cut for poles (9). 2/

During the past 20 years, annual installation of poles has increased as follows: The average from 1935 to 1939 was 3.6 million poles; from 1940 to 1945, 3.8 million; and in 1952, approximately 6.5 million (8). Most of these poles were used in power, telegraph, and telephone lines.

Continued increase in pole installation is not anticipated, however. Recent estimates indicate that by 1975 pole requirements will level off at about 5 million poles annually (8).

The principal species used by the pole industry is southern yellow pine (Pinus spp.). Seventy-three percent of the poles given a preservative treatment in 1954 were of these species (5).

Kotok (4) has pointed out the desirable qualities of ponderosa pine (Pinus ponderosa Laws.) as a pole wood. This species has also been recognized for some time in the American pole standards (1). Yet, to date, it has been used for poles in relatively small amounts. Ponderosa pine has consistently constituted 1 percent or less of the poles treated in the United States (6).

Even in areas where ponderosa pine is the principal timber species, pole production has been of secondary importance. As recently as 1955, sawtimber cut for poles in South Dakota was only 488,000 board-feet, or 2.26 percent of the total annual cut (7). Presumably, these poles were ponderosa pine, the only pole species in the area. This volume probably accounted for the production of about 5,550 poles. 3/

2/ Underlined numbers in parentheses refer to Literature Cited, page 11.

3/ Based on a conversion factor of 88 board-feet per pole, as used in Timber Resource Review, Chapter IX, Appendixes (9).

This report summarizes data collected in the northern Black Hills during the summer of 1955. The purpose of the study was to obtain basic data about the timber resource to be used for industrial planning or expansion. One of the specific objectives was to determine the quantity and quality of ponderosa pine poles in the general area.

STUDY AREA

The area studied consists of approximately 800,000 acres of public and private land in the northern Black Hills. It is bounded on the south by the Black Hills Base Line. The west, north, and east boundaries approximately follow the lower extent of the timber type, which is more or less coincident with the boundaries of the Black Hills National Forest.

The principal timber type is ponderosa pine. Minor amounts of white spruce (Picea glauca (Moench) Voss) type occur along stream bottoms. Lesser species include quaking aspen (Populus tremuloides Michx.), paper birch (Betula papyrifera Marsh.), and bur oak (Quercus macrocarpa Michx.).

Four age classes of ponderosa pine are recognized on the Black Hills National Forest. Reproduction, age class 0 to 50 years, and poles, age class 51 to 100 years, each occupy approximately 183,000 acres. About 295,000 acres are in thrifty-merchantable, age class 101 to 160 years. Mature-merchantable, age class 161 years and older, occupies 71,000 acres. The remainder of the study area is nontimbered, inaccessible, or in the white spruce type.

SAMPLING PROCEDURE

This investigation was confined to the timber in two age classes, 51 to 100, and 101 years and older. Thrifty-merchantable and mature-merchantable were combined in the latter age class. Forty 1/5-acre sample plots were randomly located in the 51-100-year age class; and 63 plots, in the 101+-year age class. The two age classes constituted 68 percent of the total area and 75 percent of the area in the ponderosa pine type. The young age class (0-50 years) was not sampled because trees in this category are generally below standard pole size.

On each 1/5-acre sample plot, all of the trees 10.0 inches d.b.h. (diameter outside bark at 4.5 feet above the ground) and

larger were tallied by species, d.b.h., and height to a 7-inch top diameter inside bark, to the nearest standard pole length (1). If the tree was not suitable for a pole, the observable cause for rejection was recorded as knots, crook, rot, sweep, or scar. Each tree was also tallied as cut or leave, according to the marking system for sawtimber currently in use on the Black Hills National Forest (3). The site class, as defined by Harmon (3), was also recorded. Briefly, site classes (areas) I, II, and III refer to bottom, sidehill, and ridge, respectively, with minor adjustments for soil and aspect.

Within each 1/5-acre sample plot, a 1/25-acre subplot was established. Additional measurements made on trees 10.0 inches d.b.h. and larger (sample trees) on the subplot included diameter outside bark, bark thickness at 7 feet from the ground, and total height.

Diameter inside bark at 7 feet from the ground was computed. Linear regression analysis was used to relate diameter inside bark at 7 feet to d.b.h.

RESULTS

The Pole Supply

An estimated 3,771,000 ponderosa pine pole trees are available for cutting in the study area. This number is in addition to the 10,051,000 reserved for sawtimber management and the 11,348,000 that failed to qualify as potential poles (table 1).

Table 1.--Ponderosa pine poles in the northern Black Hills by age class[1/]

Age class	Pole trees					Area
	Sound			Rejects	Total	
	Reserve	Cut	Total			
	M pieces					Acres
51 to 100 years	3,983	984	4,967	2,609	7,576	183,101
101+ years	6,068	2,787	8,855	8,739	17,594	365,815
Total (51+ years)	10,051	3,771	13,822	11,348	25,170	548,916

1/ Accuracy of estimate for the 101+-year age class was found to be ±8.04% at one standard error; for the 51- to 100-year age class, ±11.72%.

The 51- to 100- year age class contains an estimated 41.38 trees 10.0 inches d.b.h. and larger to the acre. Of these, 5.37 are available for cutting. The 101+-year age class contains 48.10 trees per acre, of which 7.62 are available for cutting. The number of trees per acre range from 0 to 140 in the 51- to 100-year age class and 5 to 135 in the 101+-year age class.

Of the trees available for cutting in the 51- to 100-year age class, about 56 percent are 30 to 45 feet long, to a 7-inch top diameter inside bark; the remainder are less than 30 feet. Sixty-three percent occur in the 10- and 11-inch d.b.h. classes. In the 101+-year age class, 59 percent of the trees available for cutting are 30 to 45 feet long to a 7-inch top diameter, and 28 percent are less than 30 feet long. Forty-eight percent of the trees of pole size available for cutting in the 101+-year age class are in the 10- and 11-inch classes (tables 2 and 3; figs. 1 and 2).

Table 2.--Dimensions for ponderosa pine poles by classes. 1/

Length of pole in feet	Ground line (distance from butt)	Pole class 1	2	3	4	5	6	7	8	9	10
	Feet	Inches									
		Minimum top diameter									
		8.5	8.0	7.3	6.7	6.0	5.4	4.8	5.7	4.8	3.8
		Minimum diameter at 6 feet from butt 2/									
16	3.5					7.2	6.7	6.2	No		
18	3.5			8.9	8.3	7.6	7.0	6.5	butt		
20	4.0	10.7	10.0	9.4	8.6	8.0	7.3	6.8	requirements		
22	4.0	11.1	10.5	9.7	9.1	8.4	7.8	7.2			
25	5.0	11.8	11.0	10.3	9.6	8.9	8.1	7.6			---
30	5.5	12.7	11.9	11.1	10.3	9.6	8.9	8.3		---	
35	6.0	13.5	12.7	11.9	10.9	10.2	9.6	8.6	---		
40	6.0	14.3	13.5	12.6	11.6	10.8	10.0	9.4	Line		
45	6.5	15.1	14.2	13.2	12.2	11.5	10.5	9.9	indicates		
50	7.0	15.8	14.8	13.8	12.7	11.9	11.0	10.2	length limits		
55	7.5	16.4	15.4	14.3	13.4	12.4	11.5				
60	8.0	17.0	15.9	14.8	13.8						
65	8.5	17.5	16.4	15.3	14.3						
70	9.0	18.0	16.9								

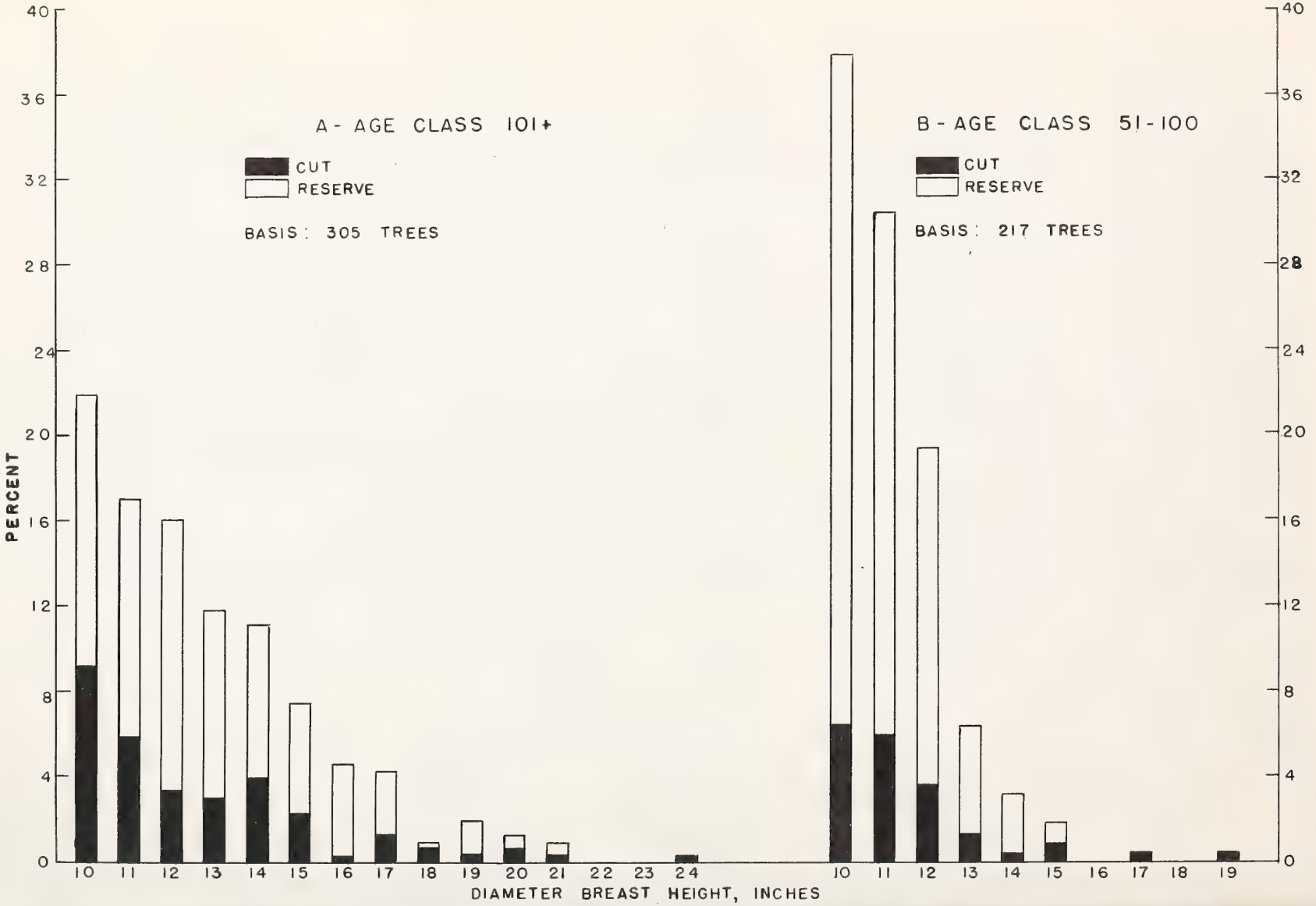
1/ Converted from American Standards Association standards.

2/ Minimum d.b.h. (outside bark) equals minimum diameter at 6 feet from butt plus 1.8 inches; e.g., the minimum d.b.h. for class 1, 40 feet, is 16.1 inches.

Table 3.--Distribution of total sound ponderosa pine pole trees in the northern Black Hills. Trees available for cutting are shown in parentheses.

D.b.h. inches 1/	Height in feet to 7-inch diameter, inside bark, to nearest standard pole length																
	16	18	20	22	25	30	35	40	45	50	55	60	65	70	75	80	Total
	No. of trees																
AGE CLASS -- 51 to 100 years; 40 sample plots 2/																	
10	3(1)	6(1)	17(2)	2(1)	27(5)	17(4)	7	3									82(14)
11	1	2(2)	7(2)		15(3)	19(4)	17	5(2)									66(13)
12			2	1	8(2)	11(1)	11(2)	7(1)	2(2)								42 (8)
13						3(1)	6(1)	4(1)	1								14 (3)
14							7(1)										7 (1)
15							3(1)		1(1)								4 (2)
16																	---
17							1(1)										1 (1)
18																	---
19									1(1)								1 (1)
Total	4(1)	8(3)	26(4)	3(1)	50(10)	50(10)	52(6)	19(4)	5(4)								217(43)
AGE CLASS -- 101+ years; 63 sample plots 2/																	
10	5(2)	3(1)	19(9)	1(1)	18(5)	10(6)	6(1)	4(3)	1								67(28)
11	3(2)		5		8(5)	15(4)	13(5)	5(1)	3(1)								52(18)
12			1		7(2)	9(2)	15(3)	9	7(3)	1							49(10)
13						11(3)	11(2)	6(2)	5(1)	2(1)	1						36 (9)
14						1	10(5)	9(2)	10(3)	2(1)	1		1(1)				34(12)
15						3	2	3(2)	6(4)	4	2	2(1)	1				23 (7)
16							1	2	4(1)	1	1	5					14 (1)
17									2(2)	6(1)	1	1(1)	3				13 (4)
18								1(1)		1	1(1)						3 (2)
19									1	2		2(1)	1				6 (1)
20									1		1(1)		1		1(1)		4 (2)
21											2(1)		1				3 (1)
22																	---
23																	---
24																1(1)	1 (1)
Total	8(4)	3(1)	25(9)	1(1)	33(12)	49(15)	58(16)	39(11)	40(15)	19(3)	10(3)	10(3)	8(1)	---	1(1)	1(1)	305(96)

1/ Midpoint of d.b.h. class at 1/2 inch; e.g., the 10-inch class includes trees 10.0 to 10.9 inches.
2/ Sample constituted 8.0 acres in the 51-100-year age class; 12.6 acres in the 101+-year age class.


A - AGE CLASS 101+
CUT
RESERVE
BASIS: 305 TREES
B - AGE CLASS 51-100
CUT
RESERVE
BASIS: 217 TREES
PERCENT
0
4
8
12
16
20
24
28
32
36
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10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
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DIAMETER BREAST HEIGHT, INCHES

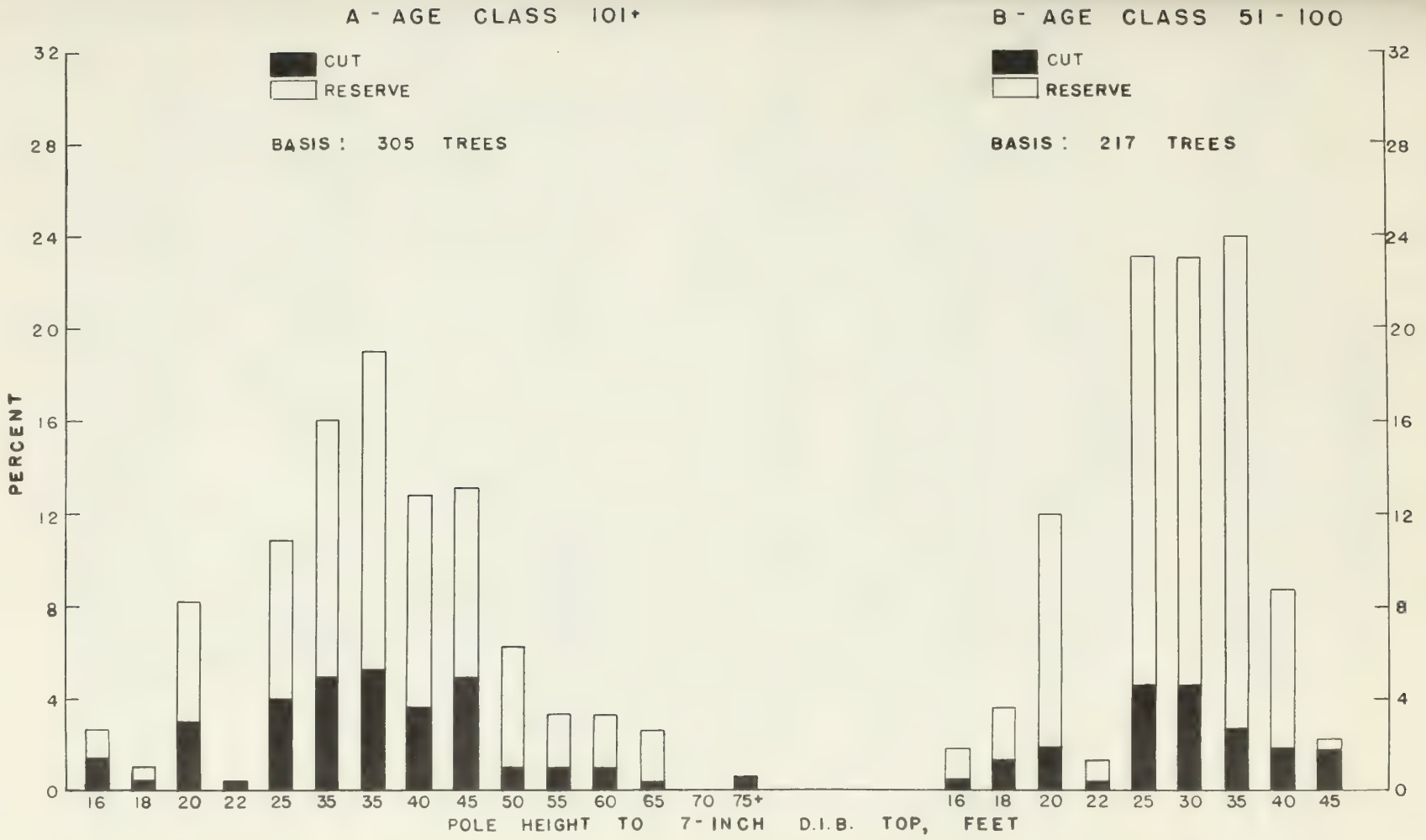

Figure 2. --Height distribution of sound ponderosa pine pole trees, Northern Black Hills.

Defect in Ponderosa Pine

Forty-five percent of the pole-size trees (10.0 inches d.b.h. and larger) were rejected as possible poles because of observable defect. Rejects included approximately 34 percent of the trees in the 51- to 100-year age class and 50 percent of the trees in the 101+-year age class.

There were several causes for rejection. Knots were most important; they accounted for approximately 20 percent of the rejected trees in both age classes. Crook was second in importance, making up 6 percent of the rejected trees in the 51- to 100-year age class and 16 percent in the older age class. Rot was about twice as prevalent, sweep was three times as prevalent, and fire scar was eight times as prevalent in the 101+-year age class as in the 51- to 100-year age class. Rot, sweep, and fire scar occurred in lesser amounts than knots and crook in both age classes.

This study was not designed to correlate the incidence of various defects with site quality. However, it appears that site has but little influence on defect. Observable defect in ponderosa pine pole trees in the northern Black Hills is summarized in table 4.

Table 4.--Occurrence of sound and defective ponderosa pine pole trees[1/] in the northern Black Hills.

Age class in years	Site class[2/]	Basis-Plots	Type of defect as observed in the standing tree						Sound	Total
			Knots	Crook	Rot	Sweep	Scar	Total		
		No.	No. of trees per acre							
51 to 100	I	8	7.50	7.50	0.62	0.62	--	16.24	36.88	53.12
	II	27	8.89	1.85	2.41	.37	0.37	13.89	23.70	37.59
	III	5	11.00	--	2.00	--	--	13.00	30.00	43.00
Average			8.88	2.75	2.00	.37	.25	14.25	27.12	41.37
101+	I	8	8.75	7.50	5.62	3.12	1.88	26.87	26.88	53.75
	II	51	8.63	8.04	4.12	.88	2.55	24.22	24.41	48.63
	III	4	3.75	6.25	2.50	1.25	--	13.75	16.25	30.00
Average			8.33	7.86	4.21	1.19	2.30	23.89	24.21	48.10
			Percent							
51 to 100			21.5	6.6	4.8	.9	.6	34.4	65.6	100.0
101+			17.3	16.3	8.8	2.5	4.8	49.7	50.3	100.0

1/ Includes trees 10.0 inches d.b.h. and larger, both cut and leave; trees observed to a 7-inch diameter inside bark top.

2/ As described for the Black Hills by Harmon (3).

Ground-line diameter

A close correlation was found to exist between d.b.h. and diameter inside bark at 7 feet from the ground (pole ground line). Ground-line diameter inside bark can be estimated by subtracting 1.8 inches from d.b.h.[4/]

DISCUSSION

The presence of 3-1/2 million poles in the northern Black Hills indicates that sufficient resource is available for the expansion of the pole industry there. However, it must be recognized that the present forest-management plan for the Black Hills National Forest is geared to the production of sawtimber. This is illustrated by the high percentage of poles that are reserved (see table 1). Pole manufacture requires what are now, or will be, the best quality trees; hence, it is evident that competition for available stumpage will continue strong. In view of this, the total number of available poles is subject to change.

Growth data were not collected in this study, but on the basis of Forest Service estimates about 90,000 poles will be available annually. This is over and above the number needed for sawtimber production.

The 41.38 trees per acre of pole size in the 51- to 100-year age class may appear somewhat low when compared with the 48.10 trees per acre in the 101+-year age class. It should be pointed out that in addition to the trees 10.0 inches d.b.h. and larger, the young age class also contains more than 90 trees per acre in trees 6.0 to 9.9 inches d.b.h. (2).

The poles classed as available for cutting in the 51- to 100-year age class must be removed as thinnings. Some are now being cut along with smaller post material. The practice

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4/ Regression line: $Y_r = -1.8 + 1.0X$. This estimate is based on measurements of 225 sample trees, located on 82 of the 103 sample plots. The trees represent the three site classes and the two age classes. Correlation coefficient, 0.999; standard error of estimate, $\pm$ 0.503 inch. These data were not tested for curvilinearity.

of harvesting more than one product simultaneously is probably necessary, since the removal of about 5 small poles per acre would hardly be economical in itself. But their removal is desirable to promote more growth on the remaining trees.

The pole trees in the 101+-year age class are a part of the mature timber stand. Those classed as available (31 percent) were based on the 3-cut shelterwood system of timber harvesting now in use on the Black Hills National Forest. The removal of these trees for poles may compete with sawtimber use. Hence, the use that can pay the highest stumpage will be the use to which the timber will be put.

No attempt has been made in this report to classify the poles according to American Standard Association pole classes (see table 2). Such a classification can be approximated, however, by comparing the data shown in table 3 with table 2. To do this, convert d.b.h. to diameter at 6 feet from the butt as described on page 9. To illustrate this procedure, let us select a pole tree 17 inches d.b.h. and 45 feet in length as shown in table 3. In converting the d.b.h. to diameter at 6 feet from the butt as described, we find this becomes 15.4 inches. We know the top d.b.h. is 7 inches because the length was estimated to this size. Referring these dimensions to table 2, we find that the maximum A.S.A. pole class this will meet is a class 4-45. The controlling factor in this case is the top diameter. The diameter at the 6-foot point is ample to meet the requirements of a class 1-45. The pole would naturally meet all the lower classes (5 to 10) 45 feet in length and shorter. However, it is generally better to produce the largest class pole the tree will make.

That the specifications for poles are rather strict is indicated by the high proportion of trees rejected as a result of observable defects. Thirty-five percent of the trees in the 51- to 100-year age class and 50 percent of the trees in the 101+-year age class were rejected. Only defects that could be readily observed externally were recorded. Other serious defects, such as spiral grain and heartrot were not observed, but it is reasonable to assume that these were also present. Hence, at best, the estimate of trees rejected as poles is low.

Knots, the most frequent cause for rejection, were about equally distributed between the two age classes. Little change in this pattern is anticipated, but pruning can now be justified on only a relatively few trees and to the height of one 16-foot log.

Crook and sweep were more common in the older age class, probably because of past growing conditions. The younger stands more nearly approach even-aged condition. Hence, as the younger stands reach maturity, less pole rejection would be anticipated from these two causes.

The larger amount of rot and fire scar in the 101+-year age class is associated with the increasing susceptibility to damage that comes with old age. Perhaps continued fire protection will prevent increase in these two defects as the 51- to 100-year age class matures.

SUMMARY

About 3,777,000 ponderosa pine poles are available for cutting in the northern Black Hills study area. This resource offers considerable opportunity for expansion of the pole industry. However, it must be recognized that poles must compete with sawtimber for the same stumpage, and the number of poles shown as available is subject to change. On the basis of current management practices, which are geared to the production of sawtimber, it is estimated that 90,000 poles will be available annually.

The incidence of pole defect is high in the ponderosa pine of the northern Black Hills. Approximately 45 percent of the trees 10.0 inches d.b.h. and larger were found to be unsuitable for poles because of observable defect. In addition, an undetermined percentage of these trees would probably be unsuitable because of defects that could not be observed in the standing tree.

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